

1922
L94

**DETERMINATION OF THE LATENT HEATS OF VAPORIZATION
OF A FEW COMMERCIAL FATTY ACIDS**

BY

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THESIS

FOR THE

DEGREE OF BACHELOR OF SCIENCE

IN

CHEMICAL ENGINEERING

COLLEGE OF LIBERAL ARTS AND SCIENCES

UNIVERSITY OF ILLINOIS

1922

1922
L94

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UNIVERSITY OF ILLINOIS

August 12 1922

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OF A FEW COMMERCIAL FATTY ACIDS

IS APPROVED BY ME AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE

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ACKNOWLEDGMENT

The writer wishes to express his sincere appreciation to Dr. J. H. Reedy for his interest and kindly criticism in the preparation of this thesis.

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THE DETERMINATION OF THE LATENT HEATS OF VAPORIZATION OF
A FEW COMMERCIAL FATTY ACIDS.

I. INTRODUCTION.

Most of the fatty acids dealt with in this investigation are used industrially in the manufacture of laundry soaps and washing powders. With the exception of the stearic and oleic acids the stock was obtained from low grade greases and foots. The crude vegetable oils consist principally of a mixture of the glycerides of palmitic, linoleic and oleic acids with varying amounts of the glycerides of arachidic and stearic acids. In addition to these glycerides there are also present the glycerides of all these acids in various stages of decomposition.

Crude cottonseed oil for example is usually refined with caustic soda, whereby the partially and wholly decomposed glycerides are separated out as a soap technically known as foots. This soap is only partially saponified and contains considerable quantities of neutral oil, together with most of the coloring, nitrogenous and mucilaginous matter that was present in the crude oil. The composition of the foots will vary considerably, depending to a great extent upon the source and upon the amount of neutral oil retained in refining.

The foots may be "killed" and acidulated, i.e., the saponification may be completed by boiling with sufficient alkali and the resulting soap treated with mineral acid to liberate the fatty acids.

Another method may be used in which the foots may be first treated with a mineral acid to free it from alkali, and then saponified by the Twitchell or other process to split off the remaining glyceryl radicals. In either case the resulting product is a mixture of free fatty acids, which must be steam distilled to remove the objectionable coloring matter before they can be utilized in the manufacture of soap.

In the design, development, and calculation of costs of operation of these distillation plants one of the important factors is the latent heat of vaporization of these fatty acids.

II. REVIEW OF LITERATURE.

A search of the literature gave a great deal of information concerning the methods for the determination of the latent heats of vaporization of simple substances that boiled under atmospheric pressure without decomposition. The only article on the substances in question was written by Julius Alsberg¹ when engaged in development work along the lines of fatty acid distillation.

He suggested that the heat of vaporization could be calculated from the vapor pressure curves of the fatty acids but preferred to determine a heat balance of a distillation plant which was available. Two distillations were run on entirely different lots of fatty acids and several months allowed to elapse between runs. The distillation plant was operated on fresh fatty acid stock, with no fatty acid or pitch left in the still from previous distillations. Before starting the tests distillation was carried on until conditions were con-

stant. A flying start and stop of the tests were used in a manner similar to that employed in making evaporative boiler tests. Thus without interruption or disturbance of the distillation, tests were started and stopped immediately after emptying the condenser drums. The plant consisted of a coal fired still, supplied with superheated steam through a reducing valve and a separately fired superheater. This still was fed continuously so that the volume in the still was constant, the level in the gauge glass being carefully watched. The combined fatty acid vapor and superheated steam passed over from the still to a water cooled tubular type condenser. Here the fatty acids were condensed and collected in a drum at the bottom of the condenser. The distilled fatty acids were allowed to stand until laboratory tests showed that all the moisture had settled out.

The steam passed over to a barometric condenser, and the fixed gases were taken care of by a vacuum pump. The barometric condenser discharged into a separatory catch basin, where the small quantity of entrained fatty acid was recovered by skinning.

The cooling water was carefully weighed, allowance being made for surface evaporation from the top of the open condenser and scale tanks. This allowance was based on actual loss in evaporation of an open vessel immersed in the top of the condenser.

The quantity of steam was determined by a specially calibrated Gebhardt steam flow meter located between the reducing valve and the superheater.

From the tabulated data Alsberg struck a heat balance. In this

balance it was assumed that the steam as measured was dry and saturated. An error of perhaps one-half of one per cent enters here. It was further assumed that there was practically no condensation in the vapor pipe connecting the still with the condenser.

Heat Balance

Total heat above 32°F in the fatty acid distilled.	(Heat taken up by (condensing water)	+	(Heat lost by evapo- (ration of conden- (sing water)
	(Heat lost by ra- (diation from con) (denser shell)	-	Total heat above 32°F of steam entering condenser
	(Total heat above (32°F of steam)	+	(Heat above 32°F in) (water carried over)
	(leaving conden-) (ser)	+	(with stock into) (settling tank)
	(Heat to raise) (stock in drum)		(Heat to raise stock) (from catch basin)
	(from 32 F to) (drum temperature)	+	(from 32 F to con-) (denser temperature)

Alsberg then gives the following values for cottonseed oil fatty acids.

130.5 B.t.u./_{lb} at 24.51 inch vacuum

118.0 B.t.u./_{lb} at 25.14 inch vacuum

Alsberg accounts for the discrepancy by the difference in the stock used for the two determinations, and by the fact that the tests were made at different pressures and temperatures.

Alsberg admits a discrepancy of 9 per cent whereas the actual discrepancy is nearer 11 per cent as calculated from his figures. The actual pressures within the apparatus in each case were 4.45

inches and 4.59 inches of mercury. This difference is too small to account for an 11 per cent difference in results.

III. EXPERIMENTAL.

It was decided to make calorimetric determinations on several commercial samples and later to attempt to check these values from the vapor pressure curves of the fatty acids by means of the Clausius-Clapeyron equation.

One of the most serious causes of error in all calorimetric work is the more or less uncertain correction for cooling. This was obviated by the use of a modified form of a Parr Adiabatic Calorimeter.

The still used in conjunction with the adiabatic calorimeter was similar to a modified form of Kahlenberg's apparatus that was used by T. W. Richards and J. H. Mathews² in their redetermination of the heat of vaporization of water. (Figure I)

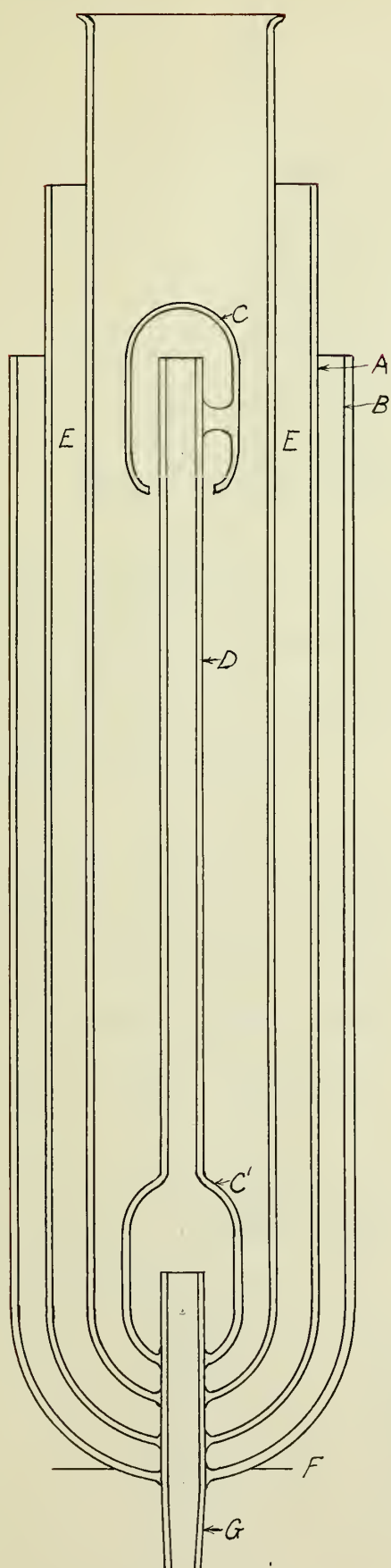
The boiling liquid was surrounded by a vacuum jacket whose walls were about one centimeter from the walls of the boiling compartment save at the bottom where the space was five millimeters across. In addition to a hood covering the upper end of the vapor delivery tube, the tube was also provided with another trap to catch and retain any liquid that might in any way gain access thereto. This distance between it and the condenser might be reduced to a minimum, yet it was surrounded by the boiling liquid in order to prevent condensation within it. The heating coil was placed so low as to make

sure that the liquid surrounding the trap was at the boiling point. The interior of the vacuum jacket was brightly silvered to a height of 4 or 5 centimeters, the silvering being on both walls, so that the heat passing from the boiling liquid to the calorimeter water by radiation had to pass through two brightly silvered surfaces and a vacuum space. The conduction of heat to the calorimeter through the glass itself cannot be prevented, but was made small by having the glass as light as was consistent with the strength demanded.

The apparatus that was tried for the distillation of the fatty acids was practically a duplication of Richards apparatus with the following two exceptions. A jacket filled with cottonseed oil was placed between the Dewar jacket and the boiling compartment. The heating element was placed in this oil bath because it was thought that local heating of the fatty acids in immediate contact with the wire would cause considerable decomposition.

The objection to this apparatus was that in spite of all precautions bumping was so violent that some liquid was unquestionably carried over. The acids worked with were mixtures of constituents whose boiling points varied over 30^o C. The lighter fractions would distill early. The heavier fractions that were spattered on the hot walls of the oil bath vaporized and later condensed in the delivery tube. This made a calorimetric determination out of the question for the length of time available.

The Clausius-Clapeyron relation may be written in various forms the more common being



LEGEND

- A Silvered surface
 - B Silvered surface
 - C Vapor trap
 - C' Vapor trap
 - D. Delivery tube
 - E. Electrically heated oil jacket
 - F. Water line
 - G. Delivery tube to condenser
- Entire apparatus made of Pyrex Glass.

Figure I

$$l = \frac{P}{J} (v'' - v') \frac{T}{P} \frac{dP}{dT}$$

T = absolute temperature at boiling point.

l = latent heat of vaporization per unit weight.

P = absolute pressure.

J = Joules mechanical equivalent of heat.

v'' = specific volume of vapor.

v' = specific volume of liquid.

$\frac{dP}{dT}$ = the temperature rate of change of pressure or the slope of the vapor pressure curve.

For all practical purposes v' is so small as compared to v'' that it may be neglected without a serious error. In this form it is necessary to determine the specific volume of the vapor at the pressure in question.

At this time W. K. Lewis and H. C. Weber³ published a method of estimating the vapor pressure of a liquid at any temperature, one point on whose vapor pressure curve is known, and a method of getting heats of vaporization from vapor pressure data by a consideration of the Clausius equation.

At reduced pressures vapors may be considered to obey the gas laws and the Clausius equation applied to vaporization of a liquid may be written:

$$(1) \quad \frac{dP}{PdT} = \frac{L}{RT^2} \quad \text{in which}$$

L = molal heat of vaporization

R = the gas constant

The vapor pressure curves of all liquids possess great curvature; consequently where only a few points on a curve are known it is very difficult to interpolate either mathematically or graphically with accuracy. On the other hand the vapor pressure curves of all liquids are more or less parallel and it is a fact that if instead of plotting the vapor pressure of a liquid at a given temperature one will plot against the temperature, the temperature at which some liquid of reference, e.g., water, exerts the same pressure, one will obtain a curve which is very flat, often sufficiently so to be considered a straight line over a wide range of temperature. This fact was first developed by J. Johnston⁴.

The Clapeyron relation as applied to the liquid of reference is:

$$(2) \quad \frac{dP_w}{P_w dT_w} = \frac{L_w}{RT_w^2}$$

The method of plotting T_w against T , given above is equivalent to placing $P = P_w$, when also $dP = dP_w$.

Dividing equation (1) by equation (2) we obtain

$$(3) \quad \frac{dT_w}{dT} = \frac{L}{L_w} \frac{(T_w)^2}{(T)}$$

The left hand side of equation (3) is the slope of the $T_w - T$ plot mentioned above. Since the curve is substantially a straight line the slope may be written $\frac{\Delta T_w}{\Delta T}$, i.e. finite temperature differences may be employed in calculation.

Water was used as the reference substance because steam tables were available. Two boiling points at two different pressures were obtained and the values substituted in the above equation.

The apparatus used to determine the vapor pressure of the fatty acids was set up as illustrated in Figure 2. A charge of the sample was placed in the still A and the cottonseed oil bath heated by means of a Bunsen burner. The pressure regulator F was partially filled with mercury, the entire apparatus closed and the vacuum pump started. The weight of mercury in the tube F kept the valves G closed until the difference in pressure between that of the atmosphere and that within the apparatus was sufficient to lift the valve. Adjustments of pressure were made by varying the amount of mercury in the regulator. The fatty acid were raised to the boiling point and refluxed until the thermometer readings were fairly constant. A series of ten readings of temperature and pressure were then recorded at one minute intervals. The average of these was assumed to be the boiling point of the sample. The pressure regulator was sufficiently sensitive to maintain the pressure within one millimeter providing all joints were tight.

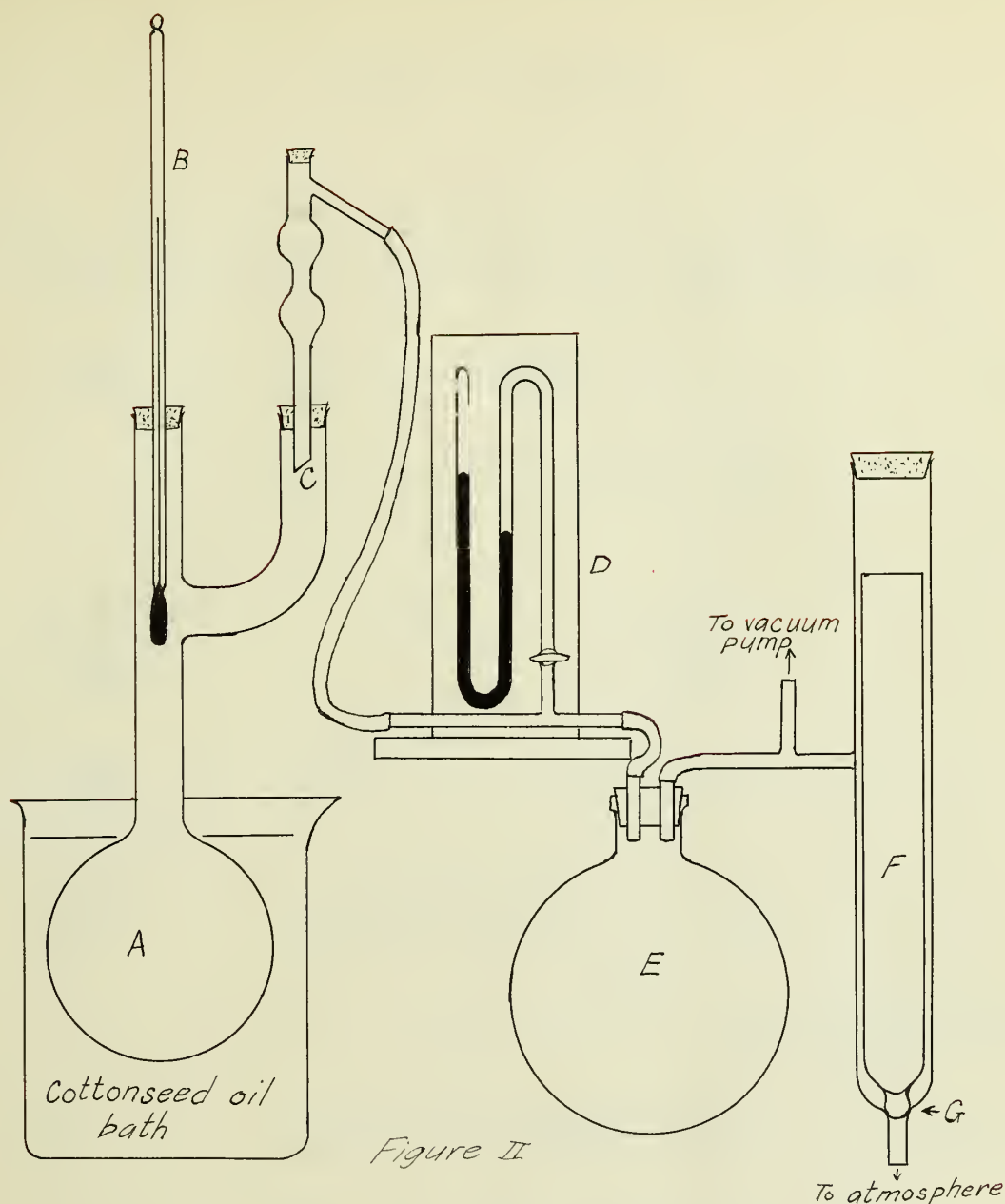


Figure II

Diagrammatic sketch of apparatus used in the determination of the vapor pressure of fatty acids.

A- Pyrex distilling flask.

B- Thermometer graduated to read to tenths of a degree.

C.- Reflux condenser.

D.- Mercury manometer.

E.- Three liter flask used to assist in pressure regulation.

F.- Mercury filled pressure regulator.

G.- Ground glass poppet valve.

Sample Calculations

Since only temperature differences are required it is not necessary to make temperature corrections for stem exposures.

$$\frac{\Delta Tw}{\Delta T} = \frac{L}{Lw} \times \frac{(Tw)^2}{(T)}$$

Baker's Purified Stearic Acid

T	P	Tw
267.7	83	47.9
248.3	38	33.2
<u>19.4</u>		<u>14.7</u>

$$\frac{\Delta Tw}{\Delta T} = \frac{14.7}{19.4} = 0.758 = \text{slope of Tw - T curve}$$

$$\frac{(Tw)^2}{(T)} = \frac{(47.9 + 273.1)^2}{(267.7 + 273.1)} = \frac{1}{2.84}$$

$$Lw = lw \times 18 \text{ where } l = \text{heat of vaporization of water per gram}$$

$$l = \frac{0.758 \times 569.7 \times 18 \times 2.84}{284.4} = 77.6 \text{ calories per gram}$$

$$77.6 \times \frac{9}{5} = 139.6 \text{ B.t.u. per pound.}$$

Baker's Stearic Acid

1st Determination			2nd Determination		
Temperature of vapor in degrees centigrade	Pressure in milli- meters of mercury	Stem temperature in degrees centigrade	Temperature of vapor in degrees centigrade	Pressure in milli- meters of mercury	Stem temperature in degrees centigrade
248.3	38	63	250.0	42	57
248.0			250.7	43	
248.3			250.1	42	
248.2			250.3		
248.7			250.0		
248.1		64	250.5		
248.5			250.4		
248.8			250.2		
248.4			250.8		
248.0			250.2		
Av. 248.3	38	63	Av. 250.3	42	59
267.8	83	75	269.0	90	60
267.9			269.1		
267.1			269.5		
267.9			269.7		
268.0		76	269.4		
267.2			269.6		
267.5			269.8		
267.9			269.4		
267.9			269.3		
267.8			269.4		
Av. 267.7	83	76	Av. 269.4	90	61

Sample of Purified Stearic Acid obtained from the Baker
Chemical Company

Commercial Stearic Acid

1st Determination			2nd Determination		
Temperature of vapor in degrees centigrade	Pressure in millimeters of mercury	Stem temperature in degrees centigrade	Temperature of vapor in degrees centigrade	Pressure in millimeters of mercury	Stem temperature in degrees centigrade
241.9	30	64	242.0	28	48
242.1			242.4		
242.4			242.5		
242.5			242.8		
243.1		65	242.5		48
242.5			242.3		
242.9			243.0		
242.6			242.5		
242.4		68	242.8		48
242.5			242.3		
Av. 242.5			Av. 242.4		
	30	66		28	48
266.1	80	63	271.5	95	65
266.3			272.5		
266.6			272.0		
266.5			272.6		
266.8	81	65	271.6	95	65
266.9			271.8		
266.8			272.1		
266.5			272.3		
266.6	80		271.8	95	
266.3			272.1		
Av. 266.5			Av. 272.0		
	80	64		95	65

Sample of Commercial Stearic Acid obtained from
Armour's Soap and Glue Works of Chicago, Illinois.

Commercial Oleic Acid

1st Determination			2nd Determination		
Temperature of vapor in degrees centigrade	Pressure in millimeters of mercury	Stem temperature in degrees centigrade	Temperature of vapor in degrees centigrade	Pressure in millimeters of mercury	Stem temperature in degrees centigrade
249.0	62	56	246.6	52	43
249.1			246.7		
249.2			247.0		
249.4		57	246.9		
249.2			246.7		46
249.5			246.7		
249.3		58	246.5		
249.0			246.3		
249.2			246.5		
249.4		58	246.6		44
Av. 249.2	62	57	Av. 246.7	52	44
260.7	98	60	264.5	107	41
260.9			264.4		
261.0			264.6		
261.0			264.8		43
260.9		65	265.1		
260.7			264.9		
260.8			264.7		44
261.0			265.0		
261.0			264.9		
260.9		63	264.8		44
Av. 260.9	98	63	Av. 264.8	107	43

Sample of Commercial Oleic Acid obtained from
 Armour's Soap and Glue Works of Chicago, Illinois.

Baker's Oleic Acid

1st Determination			2nd Determination		
Temperature of vapor in degrees centigrade	Pressure in millimeters of mercury	Stem temperature in degrees centigrade	Temperature of vapor in degrees centigrade	Pressure in millimeters of mercury	Stem temperature in degrees centigrade
252.8	57	60	248.8	48	41
252.7			249.0		
252.8			249.1		
253.0			248.9		
253.1			249.0		39
252.8			249.2		
252.7			248.9		
252.7			249.0		
252.6		65	248.8		42
Av. 252.8		63	Av. 249.0		41
268.6	106	60	268.7	107	34
268.6			268.9		
268.7			269.0		
268.7		60	269.0		37
268.8			269.1		
268.7			269.0		
268.7		61	269.1		37
268.7			268.9		
268.8			268.8		
268.7		61	269.0		35
Av. 268.7		61	Av. 269.0	107	36

Sample of U. S. P. Oleic Acid obtained from

Baker Chemical Company

Double Distilled Garbage Grease Fatty Acids.

1st Determination			2nd Determination		
Temperature of vapor in degrees centigrade	Pressure in millimeters of mercury	Stem temperature in degrees centigrade	Temperature of vapor in degrees centigrade	Pressure in millimeters of mercury	Stem temperature in degrees centigrade
243.5	38	61	241.7	33	69
243.7	38		242.1		
243.7	38		241.9		
244.4	39	64	242.0		72
244.2	39		241.8		
243.9	38		241.9		
243.8		62	242.2		71
243.9			241.8		
243.9			242.5		
243.9		61	242.3		73
Av. 243.9	38	62	Av. 242.0	33	71
263.0	82	75	269.8	101	78
263.3			270.1		
263.3			270.3		
263.0		77	270.4		83
263.3			270.7		
262.9			270.6		
263.1		74	270.7		76
263.3			270.6		
263.1			270.3		
263.1		76	270.3		78
Av. 263.1	82	75	Av. 270.4	101	79

Sample of Double Distilled Garbage Grease
Fatty Acids obtained From Armour's Soap
and Glue Works of Chicago, Illinois.

Double Distilled Brown Grease Fatty Acids

1st Determination			2nd Determination		
Temperature of vapor in degrees centigrade	Pressure in millimeters of mercury	Stem temperature in degrees centigrade	Temperature of vapor in degrees centigrade	Pressure in millimeters of mercury	Stem temperature in degrees centigrade
247.9	49	65	249.0	50	65
248.1			248.6		
248.2			248.5		
248.3			248.9		
248.5			249.0		
248.2			248.7		
248.2			249.0		
248.2			248.8		
248.2			248.7		
248.2			248.8		
Av. 248.2	49	66	Av. 248.8	50	63
264.2	94	70	266.4	98	74
264.4			266.2		
264.3			266.1		
264.5			266.2		
265.0			265.8		
265.8			266.0		
264.9			266.3		
264.7			266.5		
264.9			266.4		
264.7			266.1		
Av. 264.7	94	70	Av. 266.2	97	76

Sample of Double Distilled Brown Grease
 Fatty Acids obtained from Armour's Soap
 and Glue Works of Chicago, Illinois

Double Distilled Coconut Oil Fatty Acids

1st Determination			2nd Determination		
Temperature of vapor in degrees centigrade	Pressure in millimeters of mercury	Stem temperature in degrees centigrade	Temperature of vapor in degrees centigrade	Pressure in millimeters of mercury	Stem temperature in degrees centigrade
212.0	64	63	208.5	62	45
212.7	66		209.0		
213.1	67		208.9		
213.2	67	64	209.3		43
213.0			209.1		
213.4			209.0		
213.3		66	209.5		40
213.0			209.3		
213.0			209.0		
213.0		66	208.5		40
Av. 213.0	67	65	Av. 209.0	62	42
223.6	110	64	225.0	111	74
223.8	110		224.8	111	
224.0	110		224.3	110	
224.1		61	224.0		73
224.0			224.5		
224.2			224.4		
224.3		61	224.6		72
224.0			224.3		
223.9			224.4		
224.0		61	224.7		73
Av. 224.0	110	62	Av. 224.5	110	73

Sample of Double Distilled Coconut Oil

Fatty Acids obtained from Armour's

Soap and Glue works of Chicago, Illinois.

Double Distilled Neats Foot Oil Fatty Acids

1st Determination			2nd Determination		
Temperature of vapor in degrees centigrade	Pressure in millimeters of mercury	Stem temperature in degrees centigrade	Temperature of vapor in degrees centigrade	Pressure in millimeters of mercury	Stem temperature in degrees centigrade
242.5	39	60	242.5	38	49
242.8			242.7		
243.0			243.1		
243.2	63	63	243.1	39	51
243.2			243.1		
243.0			242.7		
243.1			243.2		
243.3	65	65	242.8	39	50
243.0			243.5		
243.0			243.5		
243.0			243.5		
Av. 243.0	39	63	Av. 243.0	39	50
264.4	93	68	262.8	87	59
264.6			263.0		
264.7			263.3		
264.7	70	70	263.0	88	60
264.3			262.8		
264.7			263.2		
264.5			263.2		
264.6	72	72	263.0	88	61
264.7			263.0		
264.7			263.0		
264.8			263.0		
Av. 264.6	93	70	Av. 263.0	88	60

Sample of Double Distilled Neats Foot Oil

Fatty Acids obtained from Armour's Soap

and Glue Works of Chicago, Illinois

Twitchellized Soya Bean Oil Fatty Acids

1st Determination			2nd Determination		
Temperature of vapor in degrees centigrade	Pressure in millimeters of mercury	Stem temperature in degrees centigrade	Temperature of vapor in degrees centigrade	Pressure in millimeters of mercury	Stem temperature in degrees centigrade
248.8	35	62	252.2	43	50
249.0	35		252.3		
249.4	36		252.4		
250.3	37	64	252.7		
250.8	37		253.0		
249.5	36		252.6		
249.5	36	65	252.4		
249.2	36		252.3		
249.2	36		252.8		
249.0	35	63	252.5		55
Av. 249.5	36	64	Av. 252.5		53
270.0	82	75	271.0	88	51
270.2			271.2	88	
269.8			271.0	88	
269.9			271.8	89	
270.0			271.5	89	
270.4			271.5	89	
270.2		75	272.0	89	
269.8			272.2	90	
270.0			271.7	90	
270.0			271.5	89	60
Av. 270.0	82	75	Av. 271.5	89	59

Sample of Twitchellized Soya Bean Oil

Fatty Acids obtained from Armour's
 Soap and Glue Works of Chicago, Illinois

Double Distilled Corn Oil Fatty Acids

1st Determination

2nd Determination

Temperature of vapor in degrees centigrade	Pressure in millimeters of mercury	Stem temperature in degrees centigrade	Temperature of vapor in degrees centigrade	Pressure in millimeters of mercury	Stem temperature in degrees centigrade
242.2	38	48	239.5	31	63
242.7			239.3		
242.8			239.5		
242.5			239.7		59
242.2			239.3		
242.8			239.6		
242.5			239.3		
242.3			239.5		
242.4			239.8		
242.7			239.6		61
Av. 242.5	38	48	Av. 239.5	31	61
264.5	90	62	268.3	102	80
264.0	89		268.5		
264.2	90		269.0		
264.4			268.9		78
264.5			269.2		
264.7		70	269.0		
265.2	91		268.8		77
264.8	90		268.6		
264.5			269.0		
264.3		68	268.8		76
Av. 264.5	90	67	268.8	102	78

Sample of Double Distilled Corn Oil Fatty
Acids obtained from Armour's Soap and Glue
Works of Chicago, Illinois.

Double Distilled Cotton Seed Oil

1st Determination			2nd Determination		
Temperature of vapor in degrees centigrade	Pressure in millimeters of mercury	Stem temperatures in degrees centigrade	Temperature of vapor in degrees centigrade	Pressure in millimeters of mercury	Stem temperatures in degrees centigrade
254.8	47	65	251.8	47	60
255.0	50		252.3		
255.1	50		252.0		
255.1		65	251.5		
255.3			251.6		
255.1			251.6		60
255.2		64	252.0		
255.0			252.1		
255.1			252.0		
255.1		65	251.5		61
Av. 255.1	50	65	Av. 251.8	47	60
272.1	101	76	271.3	99	65
272.2			271.1		
272.4			271.2		
272.5			271.1		
272.5		75	271.4		
272.5			271.4		
272.7			271.6		
272.7			271.8		
272.7		71	271.9		
272.5			271.5		
Av. 272.5	101	74	Av. 271.4	99	65

Sample of Double Distilled Cotton Seed

Oil Fatty Acids obtained from Armour's

Soap and Glue Works of Chicago, Illinois.

TABULATED RESULTS.

1st Determination			
	Slope $\frac{\Delta T_w}{\Delta T}$	Heat of Vaporization cal./gm.	Heat of Vaporization B.t.u./lb
Baker's Stearic Acid	0.758	77.6	139.6
Commercial Stearic Acid	0.758	78.5	141.3
Baker's Oleic Acid	0.768	76.8	138.3
Commercial Oleic Acid	0.769	78.2	140.7
Double Distilled Garbage Grease Fatty Acids	0.750	78.3	140.9
Double Distilled Brown Grease Fatty Acids	0.764	78.5	141.3
Double Distilled Coconut Oil Fatty Acids	0.754	85.8	154.5
Double Distilled Neats Foot Oil Fatty Acids	0.764	78.5	141.4
Twitchellized Soya Bean Oil Fatty Acids	0.746	79.8	143.6
Double Distilled Corn Oil Fatty Acids	0.741	76.8	137.8
Double Distilled Cottonseed Oil Fatty Acids	0.782	81.8	147.5

TABULATED RESULTS.

2nd Determination

	Slope $\frac{\Delta T_w}{\Delta T}$	Heat of Vaporization cal./gm.	Heat of Vaporization B.t.u./lb
Baker's Stearic Acid	0.759	77.2	139.6
Commercial Stearic Acid	0.770	78.6	141.4
Baker's Oleic Acid	0.780	77.8	140.0
Commercial Oleic Acid	0.779	76.4	137.6
Double Distilled Garbage Grease Fatty Acids	0.743	78.1	140.7
Double Distilled Brown Grease Fatty Acids	0.736	75.6	136.1
Double Distilled Coconut Oil Fatty Acids	0.744	83.9	150.9
Double Distilled Neats Foot Oil Fatty Acids	0.765	79.0	142.1
Twitchellized Soya Bean Oil Fatty Acids	0.742	78.8	141.9
Double Distilled Corn Oil Fatty Acids	0.746	78.8	141.8
Double Distilled Cottonseed Oil Fatty Acids	0.745	78.0	140.3

V. SUMMARY.

(1) In the design, development, and calculation of the cost of operation of fatty acid distillation plants one of the important factors is the latent heat of vaporization of these acids. Very few of these values have been reported and in all cases the agreement is poor.

(2) Calorimetric determinations of the heats of vaporization of these fatty acids could not be accepted as even an approximation of the correct values due to the early condensation in the delivery tube and the conduction of heat to the calorimeter from the still. In the case of mixtures the per cent of the lighter fraction would probably be higher in the distillate and result in fictitious values.

(3) The method of determining the heat of vaporization by means of the vapor pressure curves and the Clapeyron relation is easy to carry out and is fairly accurate. The boiling points reported may be considered to be the mean boiling points of the samples in question, but would undoubtedly be different for nearly every other sample that might be tested due to some variation in composition. Decomposition goes on as the acids are heated which causes a slow but gradual increase in the boiling points.

(4) The greatest discrepancy between duplicated samples is 5 per cent. With the exception of coconut oil the heat of vaporization of the fatty acids may be taken as 78 calories per gram or 140 B.t.u. per pound. The values reported can be nothing more than approximations but may be considered to be sufficiently accurate for industrial purposes.

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